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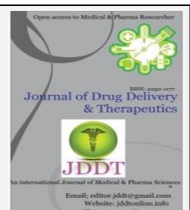

Open Access Research Article

Comparative Study of Antioxidant Activities and GC-MS Analysis of Aqueous and Ethanol Fruit Pulp Extract of (Green Kiwi Fruit) *Actinidia deliciosa* (A.Chev.) C.F. Liang & A.R. Ferguson

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ABSTRACT

The genus name Actinidia refers the Greek word aktinos (rays), which refers to the styles of the female flower, which radiate from the center and resemble the spokes of a wheel. China is the native origin of Kiwi fruit, therefore, it is national fruit of China. It is indigenous to the mountainous regions of southwestern and central china. It is mainly cultivated in Central Europe (New Zealand, Chile, Turkey, Portugal, Italy, Greece, France and Japan), United States and China. The fruits, stems and roots are used as diuretic, febrifuge and sedative. They are used in the treatment of stones in the urinary tract, rheumatoid arthralgia, cancers of the liver and oesophagus. The study aims to evaluate the antioxidant activities and GC-MS analysis of aqueous and ethanol fruit pulp extracts of *Actinidia deliciosa.* The antioxidant assays such as DPPH˙ radical, Superoxide (O_2˙-) radical, ABTS$^{\bullet+}$ radical cation scavenging activities, phoshomolybdenum reduction and Fe^{3+} reduction activities were carried out for aqueous and ethanol fruit pulp extracts. The maximum ABTS$^{\bullet+}$ radical cation scavenging activity for aqueous extract was 84.79±0.46% and ethanol extract was 79.51±0.45% at 30 µg/mL concentration and the IC_{50} for aqueous extract and ethanol extract was 10.62 and 15.20 µg/mL concentration respectively. The maximum phosphomolybdenum reduction was 92.09±0.28% for aqueous extract and 82.07±0.16% at 120 µg/mL concentration and the RC_{50} for aqueous extract and ethanol extract was 13.09 and 20.02 µg/mL concentration respectively. GC-MS analysis of aqueous fruit pulp extract showed different active compounds such as Nonanal, Flavone, Phytol with retention time 16.82, 19.92 and 26.73. Also, the GC-MS analysis of ethanol fruit pulp extract possessed various phytocompounds such as Lithic acid, Oleic acid and Vitamin D with retention time 16.15, 18.9 and 20.28. These compounds exhibit antioxidant, hypocholestrolemic, antimicrobial and anticancer activities.

Keywords: Actinidiaceae, DPPH˙ radical, Superoxide (O_2˙-) radical, ABTS$^{\bullet+}$ radical cation, Lithic acid, Oleic acid, Phenols.

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INTRODUCTION

Kiwifruit is a derivative of deciduous, woody, fruiting vine and belong to the genus Actinidia (Actinidiaceae). *Actinidia deliciosa* fruit which is oval, ovoid has semi-transparent green edible flesh, black seeds and is covered by brown hairy skin. The oblong fruit is up to 22½ inches long and the flesh, firm until fully ripe, is glistening, bright green or sometimes yellow, brownish or off-white, except for the white, succulent center from which radiate many fine, pale lines. Between these lines are scattered minute darkpurple or nearly black seeds, unnoticeable in eating (Figure 1). The flavor is sweet, tart to acid[1,2]. In India, kiwifruit (*Actinidia deliciosa*) is usually grown in the hills of Himachal Pradesh, Jammu & Kashmir and in Arunachal Pradesh[3].

Kiwifruit is a rich source of ascorbic acid and polyphenols. As an antioxidant, ascorbic acid aids in lowering the risk of arteriosclerosis, cardiovascular diseases, and some forms of cancer[4]. Whereas polyphenolic compounds (flavonoids) also have antioxidant properties and can account for some benefits associated with the consumption of fruits and vegetables[5]. Kiwifruits are used for the treatment of several types of cancers, such as, stomach, lung, and liver cancer in folk medicine[6]. As per some studies, kiwifruit helps in inhibiting growth of cancer cells[7] and also protect the cells in-vitro from oxidative DNA damage[8].

Kiwifruit contain relatively high levels of vitamin E compared to other commonly consumed fruit[9,10]. Kiwifruit contain about 2–3% of fresh weight non-starch

polysaccharides that make up the fruit cell walls, providing a valuable contribution of both soluble and insoluble fibre to the diet. The antioxidant capacity of kiwifruit constituents has been measured by means of various in vitro chemical assays that monitor the quenching, scavenging or retarding of free radical generation[11]. Kiwifruit contain several unique proteins and the cysteine protease actinidin, the most abundant protein in kiwifruit, of interest for their bioactive potential. Commonly the Kiwifruit is also called as kiwi, Chinese gooseberry, Yang-tao, Kiwifruit, Fuzzy-Skinned Kiwi and Chinese gooseberry. Kiwi fruit is a natural source of carotenoids, such as provitamin A beta-carotene, lutein and zeaxanthin[12].

Taxonomic classification of *Actinidia deliciosa*

Kingdom: Plantae
Division: Magnoliophyta
Class: Magnoliopsida
Sub Class: Magnoliidae
Order: Ericales
Super Order: Asteranae
Family: Actinidiaceae
Genus: Actinidia
Species: deliciosa
Binomial name: *Actinidia deliciosa*

Figure.1: Habitat of *Actinidia deliciosa* fruits

MATERIALS AND METHODS

Collection of fruits and preparation of extracts

The *Actinidia deliciosa* fruits were collected from the market at Nanganallur, Chennai, Tamil Nadu, India. The fruit pulp was soaked in ethanol for 72 h and the supernatant was filtered, condensed at 50ºC in a hot plate, which yields pista green gummy extract. Then the aqueous extract was obtained by soaking the fruit pulp in distilled water and boiled in cookware for 15 min. The supernatant was filtered, condensed at 50ºC in a hot plate, which yields pale green gummy extract[13,14].

In vitro antioxidant activities

DPPH˙ radical scavenging activity

The radical scavenging activity of aqueous and ethanol fruit pulp extracts of *Actinidia deliciosa* were carried out by the reduction DPPH· free radical assay method[15]. One mL of aqueous and ethanol extract with various concentrations (20-120 μg/mL) was mixed with 1 mL of 0.1 mM DPPH solution in methanol. The mixture was then allowed to stand for 30 min incubation in dark. One mL of methanol mixed with 1 mL of DPPH solution was used as the control. The decrease in absorbance was measured at 517 nm. Ascorbic acid was used as the reference standard. The percentage of inhibition was calculated as:

$$\%\ \text{of DPPH}^{\cdot}\ \text{radical inhibition} = \left[\frac{\text{Control} - \text{Sample}}{\text{Control}}\right] \times 100$$

Superoxide ($O_2^{\cdot-}$) radical scavenging activity

Superoxide ($O_2^{\cdot-}$) radical scavenging activity was carried out by the method[16] and the reaction mixture contains different concentrations (20-120 μg/mL) of aqueous and ethanol fruit pulp extracts of *Actinidia deliciosa* with 50 mM of phosphate buffer (pH 7.4), 200 μL of 1.5 mM of riboflavin, 200 μL 12 mM of EDTA and 100 μL 50 mM of NBT, added in that sequence. The reaction was started by illuminating the reaction mixture for 15 min in UV lamp. After illumination, the absorbance was measured at 590 nm. Ascorbic acid was used as the reference standard. The percentage of inhibition was calculated as:

$$\%\text{of Superoxide}(O_2^{\cdot-})\ \text{radical inhibition} = \left[\frac{\text{Control} - \text{Sample}}{\text{Control}}\right] \times 100$$

ABTS•+ (2,2-azinobis (3-ethylbenzo thiazoline-6-sulfonic acid) radical cation scavenging activity

The aqueous and ethanol fruit pulp extracts of *Actinidia deliciosa* from the stock solution was taken in various concentrations and this assay was performed according to the method[17]. The stock solutions included 7.4 mM ABTS solution and 2.6 mM potassium persulfate solution. The working solution was then prepared by mixing the two stock solutions in equal quantities and allowing them to react for 12 hours at room temperature in the dark. Fresh ABTS solution was prepared for each experiment. Aqueous and ethanol fruit pulp extracts in varying concentrations (5-30 μg/mL) were allowed to react with 500 μL of the ABTS solution for 15 minutes in dark condition and the absorbance was measured at 734 nm. Ascorbic acid was used as the reference standard. The percentage of inhibition was calculated as:

$$\%\ \text{of ABTS}^{\bullet+}\ \text{radical cation inhibition} = \left[\frac{\text{Control} - \text{Sample}}{\text{Control}}\right] \times 100$$

Phosphomolybdenum reduction activity

The antioxidant capacity of the aqueous and ethanol fruit pulp extracts of *Actinidia deliciosa* was assessed as described[18]. The aqueous and ethanol fruit pulp extracts with concentrations ranging from 20-120 μg/mL was combined with reagent solution containing ammonium molybdate (4 mM), sodium phosphate (28 mM) and sulphuric acid (600 mM). The reaction mixture was

incubated in water bath at 95°C for 90 min. The absorbance of the coloured complex was measured at 695 nm. Ascorbic acid was used as the reference standard. The percentage of reduction was calculated as:

$$\% \text{ of Phosphomolybdenum reduction} = \left[\frac{\text{Sample} - \text{Control}}{\text{Sample}}\right] \times 100$$

Ferric (Fe^{3+}) reducing power activity

The reducing power of aqueous and ethanol fruit pulp extracts of *Actinidia deliciosa* was determined by slightly modified method[19]. One mL of the aqueous and ethanol fruit pulp extracts of different concentrations (20-120 µg/mL) was mixed with phosphate buffer (1 mL, 0.2 M, pH 6.6) and potassium ferricyanide [$K_3Fe(CN)_6$] (1 mL, 1 % w/v). The mixtures were then incubated at 50°C for 20 min in water bath. 500 µL of trichloroacetic acid (10 % w/v) was added to each mixture, followed by 100 µL of Ferric chloride (0.01%, w/v) was added and the absorbance was measured at 700 nm using Spectrophotometer. Ascorbic acid was used as the standard reference. The percentage of reduction was calculated as:

$$\% \text{ of } Fe^{3+} \text{ reduction} = \left[\frac{\text{Sample} - \text{Control}}{\text{Sample}}\right] \times 100$$

Thin layer chromatography

Thin layer chromatography (TLC) was carried out for the aqueous and ethanol fruit pulp extracts of *Actinidia deliciosa* was determined by using Merck TLC aluminium sheets, silica gel 60 F254 (20 x 20 cm), preloaded plates[20]. The aqueous and ethanol extracts was spotted at 0.3 mm above from the bottom of the TLC plate. The chromatogram was developed in a mixture of suitable solvent system. The spots were visualized with UV light at 254 nm. The R_f values of the coloured spots were recorded. The ratio in which distinct bands appeared was optimized and R_f values were calculated.

Gas Chromatography–Mass Spectrometry (GC–MS) analysis

For GC-MS analysis, the samples (aqueous and ethanol fruit pulp extracts of *Actinidia deliciosa*) were injected into a HP-5 column (30 m X 0.25 mm i.d with 0.25 µm film thickness), Agilent technologies 6890 N JEOL GC Mate II GC-MS model. Following chromatographic conditions were used: Helium as carrier gas, flow rate of 1 mL/min; and the injector was operated at 200°C and column oven temperature was programmed as 50-250°C at a rate of 10°C/min injection mode. Following MS conditions were used: ionization voltage of 70 eV; ion source temperature of 250°C; interface temperature of 250°C; mass range of 50-600 mass units[21].

Identification of components

The database of National Institute Standard and Technology (NIST) having more than 62,000 patterns was used for the interpretation on mass spectrum of GC-MS. The mass spectrum of the unknown component was compared with the spectrum of the known components stored in the NIST library.

RESULTS AND DISCUSSION

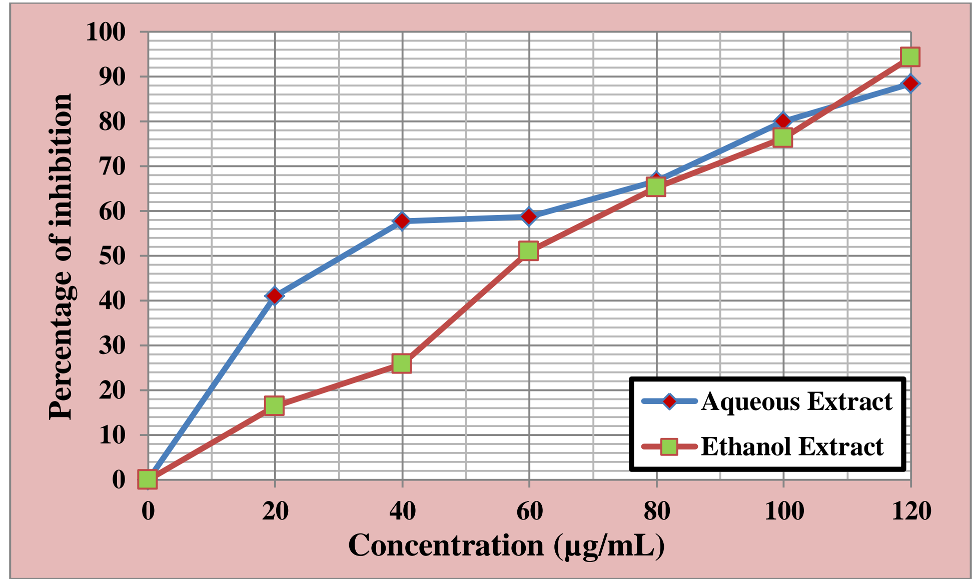
DPPH˙ radical scavenging activity

Evaluation of antioxidant activity by DPPH method is the best screening option for herbal based drugs. DPPH˙ (1,1-Diphenyl-2-picrylhydrazyl) is a stable nitrogen centered free radical which has an unpaired valence electron at one atom of nitrogen bridge[22]. The ability of aqueous and ethanol fruit pulp extracts of *Actinidia deliciosa* to scavenge free radicals formed was assessed using 1,1-diphenyl-2-picrylhydrazyl radical (DPPH). The aqueous and ethanol fruit pulp extracts of *Actinidia deliciosa* demonstrated high capacity for scavenging free radicals by reducing the stable DPPH (1,1-diphenyl-2- picryl hydrazyl) radical to the yellow coloured 1,1-diphenyl-2-picrylhydrazine and the reducing capacity increased with increasing concentration of the extracts. The maximum DPPH˙ radical scavenging activity of aqueous and ethanol fruit pulp extracts of *Actinidia deliciosa* was 94.36±0.20% and 88.41±0.39% at 120 µg/mL concentration (Table 1). The IC_{50} value for aqueous and ethanol extracts were found to be 58.88 µg/mL and 24.42 µg/mL concentrations (Graph 1) and was compared with standard (Ascorbic acid, IC_{50} = 13.24 µg/mL concentration).

Table 1: DPPH˙ radical scavenging activity of aqueous and ethanol fruit pulp extracts of *Actinidia deliciosa*

S.No	Concentration (µg/mL)	% of inhibition*	
		Aqueous extract	Ethanol extract
1	20	16.46±0.14	40.94±0.33
2	40	25.85±0.25	57.67±0.19
3	60	50.95±0.18	58.74±0.21
4	80	65.24±0.37	66.74±0.44
5	100	76.25±0.42	80.04±0.11
6	120	94.36±0.20	88.41±0.39

(*Average value of 3 replicates)



Graph 1: DPPH˙ radical scavenging activity of aqueous and ethanol fruit pulp extracts of *Actinidia deliciosa*

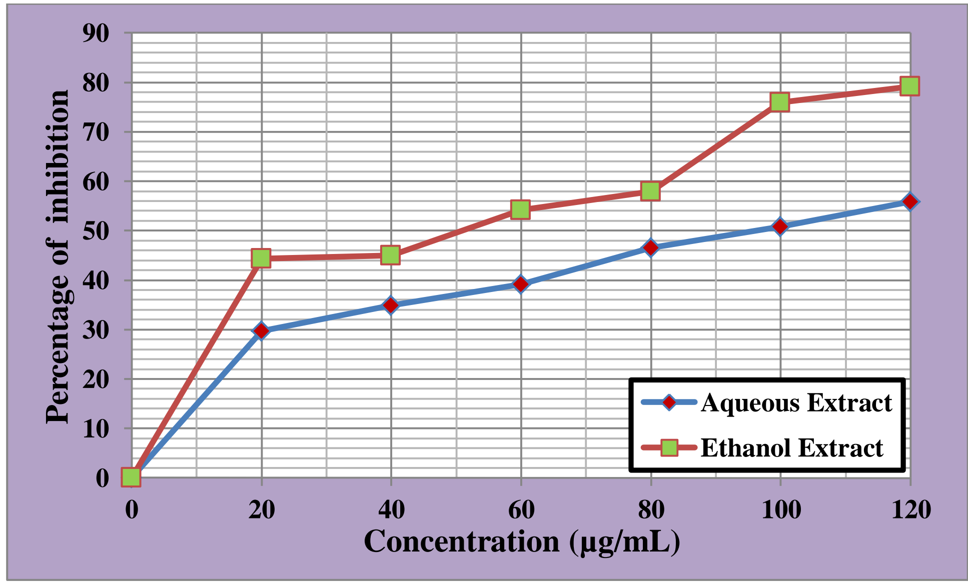
Superoxide ($O_2^{\cdot-}$) radical scavenging activity

Superoxide anion is also very harmful to cellular components and their effects can be magnified because it produces other kinds of free radicals and oxidizing agents. Flavonoids are effective antioxidants, mainly because they scavenge superoxide anions. Superoxide anions derived from dissolved oxygen by the riboflavin-light-NBT system will reduce NBT in this system. In this method, superoxide anion reduces the yellow dye (NBT^{2+}) to blue formazan, which is measured at 590 nm in UV-Vis spectrophotometer. Antioxidants are able to inhibit the blue NBT formation and the decrease of absorbance with antioxidants indicates the consumption of superoxide anion in the reaction mixture[23]. The maximum superoxide ($O_2^{\cdot-}$) radical scavenging activity of aqueous and ethanol fruit pulp extracts of *Actinidia deliciosa* was 79.14±0.28% and 55.84±0.32% at 120 µg/mL concentration (Table 2 and Graph 2) and the IC_{50} value for the aqueous and ethanol extracts were found to be 22.53 µg/mL and 85.96 µg/mL concentrations. It was compared with the standard of ascorbic acid (IC_{50} = 11.36 µg/mL concentration).

Table 2: Superoxide ($O_2^{\cdot-}$) radical scavenging activity of aqueous and ethanol fruit pulp extracts of *Actinidia deliciosa*

S.No	Concentration (µg/mL)	% of inhibition*	
		Aqueous extract	Ethanol extract
1	20	44.38±0.12	29.65±0.31
2	40	44.94±0.25	34.94±0.39
3	60	54.23±0.36	39.12±0.25
4	80	57.93±0.47	46.53±0.17
5	100	75.92±0.19	50.75±0.28
6	120	79.14±0.28	55.84±0.32

(*Average value of 3 replicates)



Graph 2: Superoxide ($O_2^{\cdot-}$) radical scavenging activity of aqueous and ethanol fruit pulp extracts of *Actinidia deliciosa*

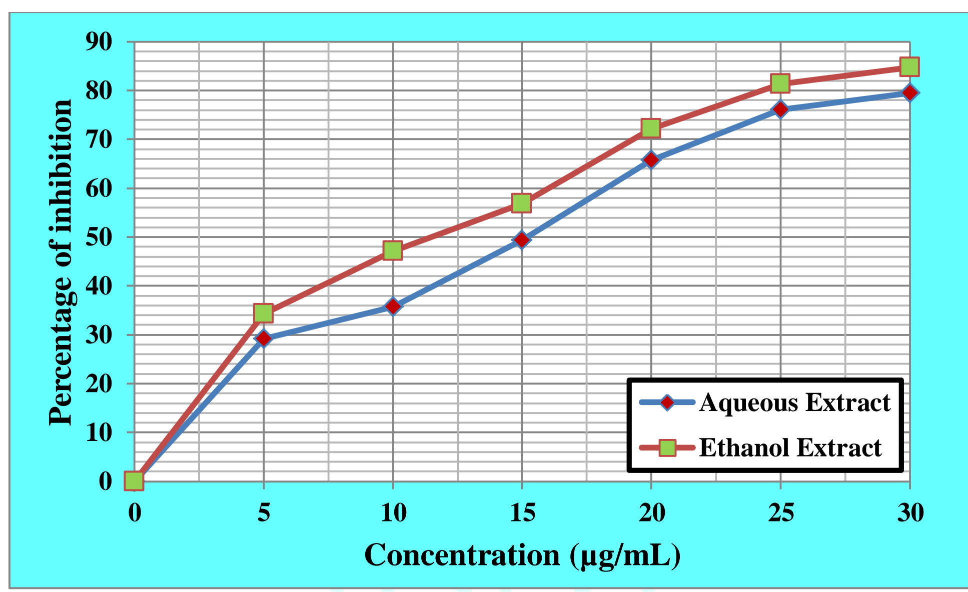
$ABTS^{\bullet+}$ radical cation scavenging activity

$ABTS^{\bullet+}$ is a blue chromophore produced by the reaction between ABTS and potassium persulfate and $ABTS^{\bullet+}$ radical cation gets reduced in the presence of aqueous and ethanol extract and the remaining radical cation concentration was then quantified at 734 nm. It can be prepared using $K_2S_2O_8$ as an oxidant. The blue-green colour of aqueous and ethanol ABTS solution is formed by the loss of an electron by the nitrogen atom of ABTS (2, 2-azinobis (3ethylbenzothiazolin-6-sulfonic acid)). The decolourization of the solution takes place in the presence of hydrogen donating antioxidant (nitrogen atom quenches the hydrogen atom[24]. The maximum $ABTS^{\bullet+}$ radical cation scavenging activity of aqueous and ethanol fruit pulp extracts of *Actinidia deliciosa* was 84.79±0.46% and 79.51±0.45% at 30 µg/mL concentration (Table 3 and Graph 3) and the IC_{50} value for the aqueous and ethanol extracts were found to be as 10.62 µg/mL and 15.20 µg/mL concentrations, which was compared with standard ascorbic acid (IC_{50} = 3.92 µg/mL concentration).

Table 3: $ABTS^{\bullet+}$ radical cation scavenging activity of aqueous and ethanol fruit pulp extracts of *Actinidia deliciosa*

S.No	Concentration (µg/mL)	% of inhibition*	
		Aqueous extract	Ethanol extract
1	5	34.28±0.12	29.14±0.36
2	10	47.06±0.43	35.68±0.18
3	15	56.82±0.38	49.33±0.24
4	20	72.11±0.26	65.74±0.33
5	25	81.37±0.19	76.05±0.11
6	30	84.79±0.46	79.51±0.45

(*Average value of 3 replicates)



Graph 3: $ABTS^{\bullet+}$ radical cation scavenging activity of aqueous and ethanol fruit pulp extracts of *Actinidia deliciosa*

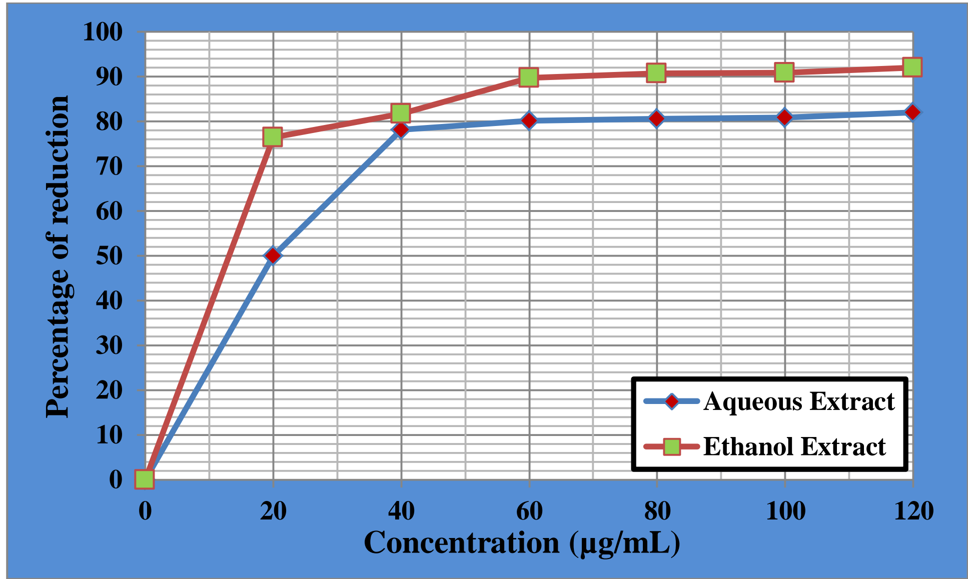
Phosphomolybdenum reduction activity

The total antioxidant activity of aqueous and fruit pulp extracts of *Actinidia deliciosa* was measured spectrophotometrically by phosphomolybdenum reduction method, which is based on the reduction of Mo (VI) to Mo (V) by the formation of green phosphate/Mo (V) complex at acidic pH, with a maximum absorption at 695 nm[25]. The maximum phosphomolybdenum reduction of aqueous and ethanol fruit pulp extracts of *Actinidia deliciosa* was 92.09±0.28% and 82.07±0.16% at 120 µg/mL concentration with the RC_{50} of 13.09 µg/mL and 20.02 µg/mL concentrations (Table 4 and Graph 4). It was compared with the standard ascorbic acid (RC_{50} = 8.53 µg/mL).

Table 4: Phosphomolybdenum reduction activity of aqueous and ethanol fruit pulp extract of *Actinidia deliciosa*

S.No	Concentration (µg/mL)	% of reduction*	
		Aqueous extract	Ethanol extract
1	20	76.39±0.47	49.95±0.26
2	40	81.75±0.25	78.22±0.35
3	60	89.71±0.19	80.14±0.17
4	80	90.75±0.36	80.55±0.42
5	100	90.95±0.41	80.84±0.11
6	120	92.09±0.28	82.07±0.16

(*Average value of 3 replicates)



Graph 4: Phosphomolybdenum reduction activity of aqueous and ethanol fruit pulp extracts of *Actinidia deliciosa*

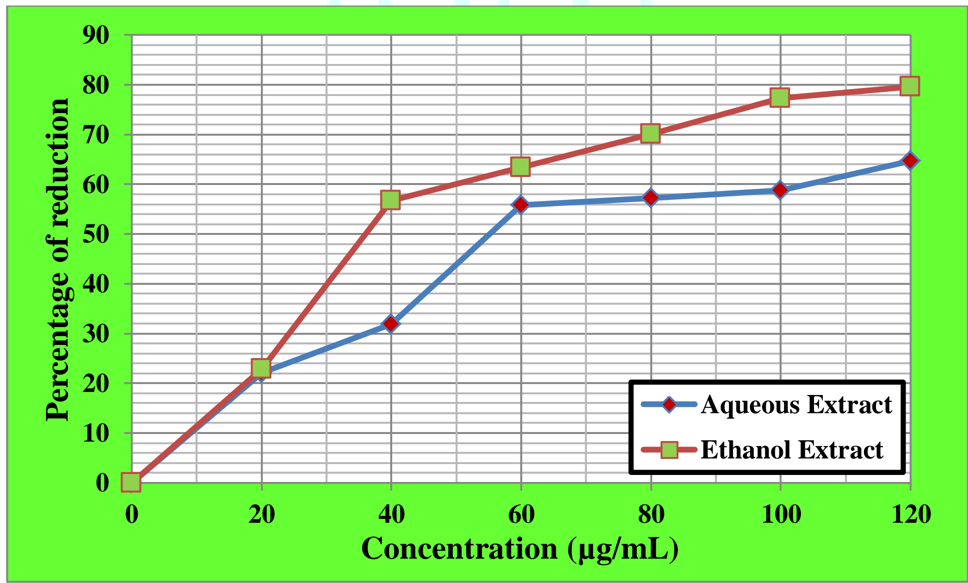
Ferric (Fe^{3+}) reducing power activity

The reducing power of Fe^{3+} to Fe^{2+} by aqueous and ethanol fruit pulp extracts of *Actinidia deliciosa* was studied and showed reduction ability in a dose dependent manner. The maximum reduction of aqueous and ethanol fruit pulp extracts of *Actinidia deliciosa* was 79.57±0.19% and 64.63±0.27% at 120 µg/mL concentration (Table 5 and Graph 5). Fe (III) reduction is often used as an indicator of electron donating activity, which is an important mechanism of phenolic antioxidant action[26]. The RC_{50} value for aqueous and ethanol fruit pulp extracts of *Actinidia deliciosa* as found to be 35.24 µg/mL and 53.81 µg/mL concentrations and was compared with the standard (21.80 µg/mL concentration) Ascorbic acid.

Table 5: Ferric (Fe^{3+}) reducing power activity of aqueous and ethanol fruit pulp extracts of *Actinidia deliciosa*

S.No	Concentration (µg/mL)	% of reduction*	
		Aqueous extract	Ethanol extract
1	20	22.84±0.28	22.12±0.46
2	40	56.75±0.34	31.88±0.15
3	60	63.44±0.12	55.75±0.28
4	80	70.06±0.44	57.26±0.39
5	100	77.35±0.37	58.72±0.10
6	120	79.57±0.19	64.63±0.27

(*Average value of 3 replicates)



Graph 5: Ferric (Fe^{3+}) reducing power activity of aqueous and ethanol fruit pulp extracts of *Actinidia deliciosa*

Thin Layer Chromatography

Thin layer chromatography analysis was carried out in the solvent system of Toluene: Ethyl Acetate for aqueous fruit pulp extract of *Actinidia deliciosa* in 1:1 ratio. Similarly, for ethanol fruit pulp extract of *Actinidia deliciosa* Toluene: Methanol in 1:1 ratio was preferred as solvent system.

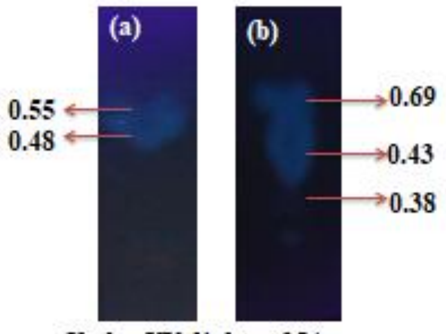


Figure.2: Separation of active compounds by Thin Layer Chromatography

The separated compounds by chromatographic analysis were showed in Figure 2 and retention factor was calculated based on the solvent front.

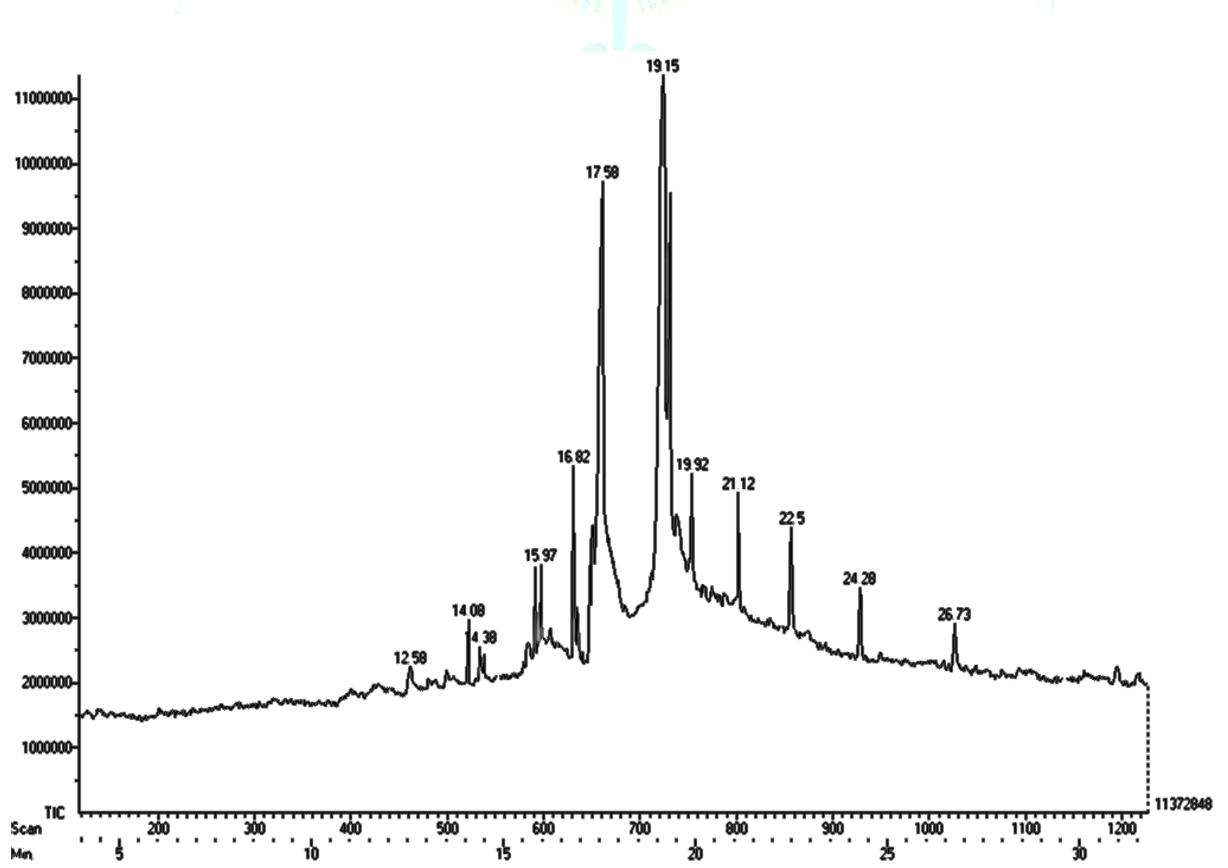
Gas Chromatography–Mass Spectrometry (GC–MS) analysis

GC-MS is an analytical technique used for many applications which has very high sensitivity and specificity. In recent years GC-MS studies have been increasingly applied for the analysis of medicinal plants as this technique has proved to be a valuable method for the analysis of nonpolar components and volatile essential oil, fatty acids, lipids and alkaloids. It also plays a fundamental role as an analytical technique for quality control and standardization of phytochemical molecules[27,28,29]. The GC-MS analysis of aqueous and ethanol fruit pulp extracts of *Actinidia deliciosa* (Table 6 and Table 7) revealed the presence of different bio-active compounds (phytochemical constituents) that could contribute the antioxidant and therapeutic benefits of the kiwi fruit (Table 8). The identification of the phytochemical compounds was confirmed based on the peak area, retention time and molecular formula (Graph 6 and Graph 7). The active principles with their Retention time (RT), Molecular formula and Molecular weight (MW) were recorded.

Table 6: Elution of active compounds present in aqueous fruit pulp extract of *Actinidia deliciosa* by GCMS analysis

S. NO	COMPOUND NAME	RT	COMPOUND STRUCTURE	MOLECULAR WEIGHT (g/moL)	MOLECULAR FORMULA
1.	3-Penten-2-ol	14.08	HO	86.01	$C_3H_6O_3$
2.	2-Hexanol	15.97	OH	101	$C_9H_{21}N$
3.	Nonanal	16.82	O	142	$C_6H_6O_6$
4.	Cyclohexanol, 1-methyl-4-(1-methylethylidene)-	17.58	OH	154	$C_5H_4N_4O_3$
5.	Phenol, 2,4-bis(1,1-dimethylethyl)-	19.15	OH	206.03	$C_{15}H_{30}O$
6.	Flavone	19.92	O O	222	$C_{16}H_{32}O_2$

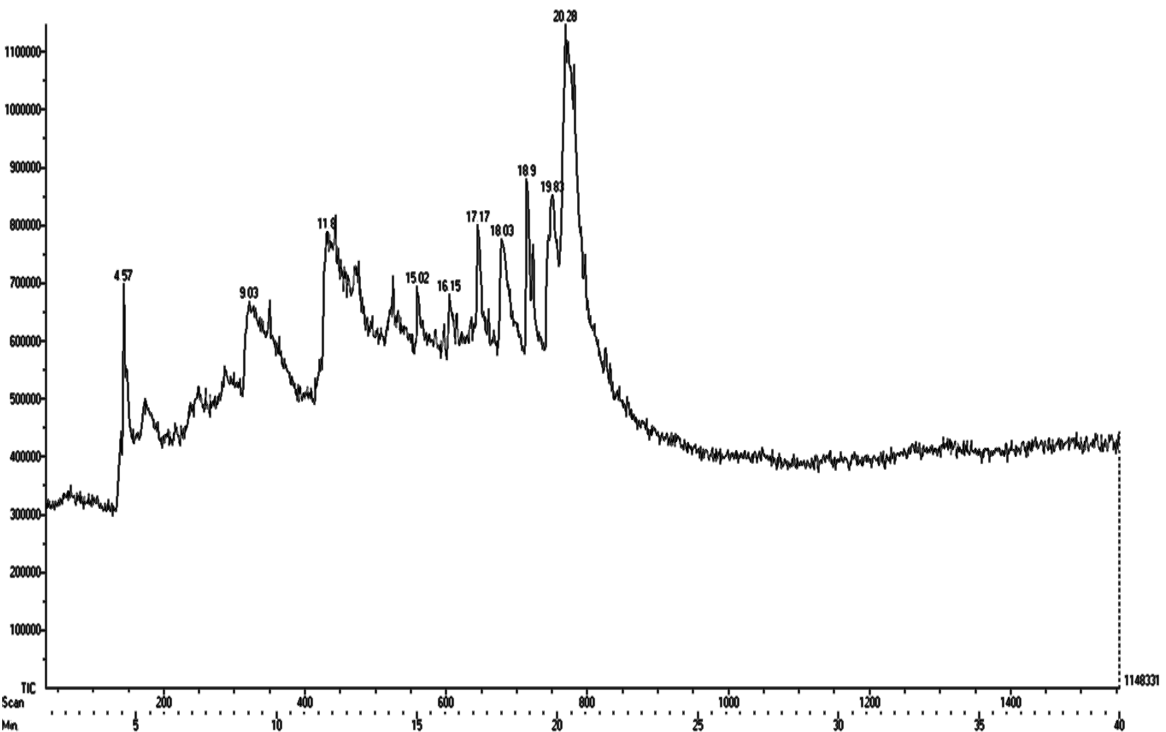
7.	Ethyl(2E,4E)-3,7,11-trimethyl-2,4-dodecadienoate	21.12		266.55	$C_{18}H_{34}O_2$
8.	Z,E-2-Methyl-3,13-octadecadien-1-ol	22.5		280.58	$C_{20}H_{30}O$
9.	Methyl-a-ionone	12.58		205.85	$C_{27}H_{44}O$
10.	Oleic acid	24.28		282	$C_6H_{12}O_6$
11.	Phytol	26.73		296	$C_{20}H_{40}O$
12.	2-Butanone, 3-hydroxy-	14.38		88	$C_4H_8O_2$



Graph 6: GCMS Chromatogram of aqueous fruit pulp extract of *Actinidia deliciosa*

Table 7: Elution of active compounds present in ethanol fruit pulp extract of *Actinidia deliciosa* by GCMS analysis

S. NO	COMPOUND NAME	RT	COMPOUND STRUCTURE	MOLECULAR WEIGHT (g/moL)	MOLECULAR FORMULA
1.	di-Glyceraldehyde	4.57		90.07	$C_3H_6O_3$
2.	1- Octamine, N-methyl-	9.03		143.26	$C_9H_{21}N$
3.	Nonanoic acid, 1-methylethyl ester	15.02		174.10	$C_6H_6O_6$
4.	Lithic acid	16.15		168.11	$C_5H_4N_4O_3$
5.	3-Pentadecanone	18.17		226.39	$C_{15}H_{30}O$
6.	Pentadecanoic acid, methyl ester	18.03		256.42	$C_{16}H_{32}O_2$
7.	Oleic acid	18.9		282.47	$C_{18}H_{34}O_2$
8.	Retinol	19.83		286.45	$C_{20}H_{30}O$
9.	Vitamin D	20.28		384.64	$C_{27}H_{44}O$
10.	Glucose	11.8		180.15	$C_6H_{12}O_6$



Graph 7: GCMS Chromatogram of ethanol fruit pulp extract of *Actinidia deliciosa*

Table 8: Pharmacological activities of aqueous and ethanol fruit pulp extracts of *Actinidia deliciosa*

S.No	Compound Name		Pharmacological activity	
	Aqueous Extract	**Ethanol Extract**	**Aqueous Extract**[30-33]	**Ethanol Extract**[34-40]
1	Phenol, 2,4-bis(1,1-dimethylethyl)-	Nonanoic acid, 1-methylethyl ester	Antimicrobial activity Antioxidant activity Antimalarial activity Immuno-modulatory effect	Plasticizers and Lacquers preparation
2	Flavone	Pentadecanoic acid, methyl ester	Production of Reactive Oxygen Species (ROS) can be reduced by flavonoids. Relevance of plant defense mode of action is highly possible by flavonoids. Formation of oxygen radicals can be prevented by flavonoids thereby inhibiting the enzyme activity.	Lubricants and Adhesive agents
3	Oleic acid	Retinol	5 alpha reductase inhibitor Hypocholestrolemic activity Perfumery and flavour Cancer preventing agent Anti-inflammatory activity Antibacterial activity	Antioxidant activity Retinal isoform related to vision cycle Important signalling molecule Immune system functioning and immune enhancer Red blood cell development Cancer prevention Maintenance of adult mammalian spermatogenesis
4	Phytol	Vitamin D	Aromatic Ingredient Antinociceptive Antioxidant activity Antiallergic Anti-inflammatory activity Antimicrobial activity Immunostimulant Anticancer activity	Maturation and differentiation of mononuclear cells Facilitation of cytokine production, inhibition and proliferation of malignant cells

CONCLUSION

Natural products discovered from medicinal plants have provided a great pathway for clinically approved medicines. The approval of the selected medicines falls under pharmacokinetics and pharmacodynamics (response of both drug and the human system). Fruits, vegetables and pulses have been consumed by humans since ancient times. Scientific investigations have proved that an increased consumption of fruits, vegetables and pulses is known to reduce various diseases. Kiwi is one of the most popular delicious food having a large number of medicinal properties. It is an excellent package of bioactive compounds, nutrients and minerals, which make it a sound dietary supplement. It is useful in management of various diseases such as inflammation, HIV, hypertension, asthma, cancer and diabetes. excellent anti-oxidant potential. Clinical trials need to be carried out to exploit the therapeutic utility of Kiwi in combating various diseases. Further, the individual active compounds can be isolated by chromatographic techniques and the fractions shall be evaluated separately for FTIR, NMR to identify the compound functional group, nature and structure for converting as a new active drug.

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